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The perspectives of the urban poor in climate vulnerability assessments – The case of Kota, India

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ABSTRACT

Kota with a high proportion of slum dwellers and extremely high temperatures is under great demand to assess the vulnerability and adaptive capacity of different groups of its inhabitants to the impacts of climatic variability and change. Participatory workshops with key stakeholders in urban administration undertook a short vulnerability assessment to gauge current climate adaptation awareness and measures and discuss and decide on a numbered of proposed actions. The city has many policies and disaster management plans in place although implementation and enforcement was often found lacking. The actions were mainly about infrastructure and ecosystems with few related to boosting and transforming agent capabilities and institutions. The action plans outlining the frequency and responsible institutions for tree planting and cleaning streams also lacked detail or identification of lead institutions, departments, or people. Although stakeholders highlighted that local knowledge was not sufficiently used to inform good planning and policies, the action plans did not include community representatives in decision-making rather only in the implementation of the proposed actions. Although when the group identified slum populations as especially vulnerable the focus of the assessment shifted but in action plans representatives of this group were not included in any decision making or planning processes.

1. Introduction

Impacts from climate change are intensely felt throughout India and will likely escalate in the future. Urban populations face several large challenges due to risks from flooding, heat-trapping, water shortages and air quality deterioration (Revi, 2008; Panda, 2011) and many of the poor are particularly vulnerable (Somanathan and Somanathan, 2009; Sett and Sahu, 2014). Seventeen percent of the Indian urban population live in slums (India Habitat III Report, 2016) in poor housing with unreliable access to drinking water and sanitation and by 2060 an additional 500 million will reside in urban centres (Sharma and Tomar, 2010). Targeted actions are necessary to reduce current vulnerability and address climate adaptation issues (Dubash et al., 2013; DoE, 2010). The *Pradhan Mantri Awas Yojana* (Housing For All by 2022) scheme launched in 2015 aims to construct 20 million housing units for the urban poor, one million of those in Rajasthan (India Habitat III Report, 2016). Such large-scale constructions provide opportunities to link climate change resilience with urban planning decisions (Sharma et al., 2013).

This paper examines the outcomes of a multi-stakeholder vulnerability assessment process in Kota City, Rajasthan that involved

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urban planners and representatives of government departments and slum populations. The interventions proposed by stakeholders are organized according to the three key resilience elements identified by Tyler and Moench (2012) and the identified barriers and facilitating factors placed in Moser and Ekstrom's (2010) spatial-temporal matrix. This enabled a deeper exploration of the types of interventions, the origins of the barriers and enabling factors and the implications these might have on implementation of the suggested adaptation measures.

2. Urban vulnerability and resilience

Vulnerability as related to climate change can be seen as the extent to which a natural or social system is susceptible to experiencing damage from climate change or its impacts. Vulnerability assessments are ways to evaluate the exposure and sensitivity of different areas, sectors and societal groups to climate change impacts, as well as the capacity of citizens and institutions to respond and adapt to these changes (Füssel and Klein, 2006). The IPCC has recommended undertaking vulnerability assessments and including stakeholders at relevant geographical scales to map, explore and better understand the major challenges related to climate change and how adaptive capacity can be strengthened (Parry et al., 2007). Many vulnerability assessments have been recently conducted to identify 'hot-spots' of vulnerable populations or sectors, inform the public of climate risks and ways to strengthen adaptive capacity, target funding strategies or increase understanding of the characteristics of socio-economic systems that underpin vulnerability (Tonmoy et al., 2014). Assessments should address and bridge complex relationships and lack of synchronisation between key actors and their responsibilities, policies, planning and implementation, and take account of and respect cultural and local traditions (André, 2013; Pahl-Wostl, 2009). In urban contexts, there is often little concrete data to guide actions in ways that address root problems (Hardoy and Pandiella, 2009). State level action plans on climate change (SAPCC) began to be released in India in 2009. Although vulnerability assessments are one of the basic requirements of the plans, many states based their assessments on state level data and information (Dhanapal and Panda, 2014), rather than on more exploratory and locally based assessments that target and include sensitive groups. Indicator-based assessments facilitate the comparison of geographical regions and assessments of changes over time but they have been also criticized for being unable to capture the complexity of climate change vulnerability (Hinkel, 2011; Adger, 2006) and are dependent on high data availability, resolution and accuracy. While indicator-based assessments are good options when starting to analyse vulnerability (Tonmoy et al., 2014), for greater detail and use in practical applications, other methods such as participatory assessments and finer scales are necessary to target sensitive groups and promote social learning (Yuen et al., 2013).

Nordgren et al. (2016) suggest that local governments have the resources and methods available to undertake vulnerability assessments and adaptations plans, but not the resources and organizational capacity for implementation, monitoring and evaluation of the plans. Much climate adaptation planning follows the traditional predict and prevent approach, although the unpredictability of climate change requires other approaches that include social learning and governance (Tyler and Moench, 2012). Vulnerability assessments that promote shared or collaborative knowledge production fostered through multi-stakeholder dialogues and forums have proven successful for collecting, discussing and contrasting the knowledge, perspective and capacity of involved stakeholders to deal with different types of issues (Janarayan et al., 2007; Jonsson et al., 2005). To deal with multiple perceptions and priorities, the processes benefit from a structured yet flexible design that can be modified according to local institutional strengths, capacities and identified needs (Alkan-Olsson et al., 2011; Jonsson & Wilk, 2014; Steyaert et al., 2007; Chu et al., 2016). Social learning can evolve from more inclusive approaches to urban climate adaptation planning. Inclusive approaches are important in addressing equity issues, exploring multiple framings of an issue and supporting collective actions (Chu et al., 2016; Yuen et al., 2013).

Many urban centres currently strive to enhance their resilience to meet the intensified challenges of climate-related impacts, and networks such as ICLEI, ACCCRN and Resilient Cities are continually gaining new members. Resilience can be defined as "…the ability to absorb disturbances, to be changed and then to re-organize and still have the same identity" (Sharma et al., 2013, p.13). Most approaches and frameworks that describe and promote resilience, point out the need for diversity, flexibility, adaptive governance and capacity of learning (Leichenko, 2011) and the importance of linking climate resilience strategies with other development policies and plans, so they might even be realised at lower cost (Hardoy and Pandiella, 2009). Although resilience often is treated as the reverse side of vulnerability, it is more closely related to adaptive capacity, one of the components of vulnerability along with exposure and sensitivity (Gallopin, 2006).

The Urban Climate Resilience Planning Framework (Tyler and Moench, 2012) points out three key elements that need to be strengthened to increase capacity to deal with climate change and its impacts: systems, including infrastructure- and ecosystems, agent capabilities and institutions. This approach proposes that resilience is high where "*robust and flexible systems* can be *accessed by high-capacity agents* and where that access is *enabled by supportive institutions*" (Tyler and Moench, 2012: 318). Although resilience could be applied on an aggregated city level, the suggested approach puts focus on vulnerable populations in locations that suffer from infrequent and irregular access to services and builds on shared learning dialogues, vulnerability assessments and sector studies (Sharma et al., 2013). A criticism of the resilience concept when used as a framework is that it supports people's maintenance of their current status (Friend and Moench, 2013) without recognition that many poor people need to improve their current state in terms of assets and security, rather than to merely bounce back to pre-disturbance levels. The authors argue that long-term changes must also be in focus in vulnerability assessments and resilience frameworks to empower the poor and vulnerable to access resources and assets to change their situations. This involves recognising the underlying drivers of poverty and inequality (Gaillard, 2010) and focussing on issues of people, politics and power (Bahadur and Tanner, 2014).

Resilience's premise of bouncing back when placed on the "contested social world" may ignore or disavow other social criticisms and realities related to equality, poverty or social justice (Friend and Moench, 2013). Despite its limitations, the same authors argue

that the resilience concept gives opportunity for improving understanding of issues and dynamics related to poverty and vulnerability by discussing and recognising their causes to reduce vulnerabilities by addressing the structural dimensions of poverty. However, equity concerns arising from uneven patterns of resilience within cities need to be seriously addressed (Leichenko, 2011). Deliberate transformation has been called for in recent studies to adequately address the complex challenges stemming from climate change. This entails "changes to entrenched systems maintained and protected by powerful interests" (O'Brien, 2011). Such changes and re-organizations or larger institutions would also hold the potential to shift the balance of political and cultural power in society (Bahadur and Tanner, 2014).

Chu et al. (2016) strongly support the need of inclusive approaches to urban climate adaptation planning and implementation and propose that successful inclusiveness has been reached if the processes attain: consideration of the needs of the vulnerable residents, procedural representation and equity, and just adaptation outcomes. In this paper, we hypothesize that without involving the perspectives and priorities of the urban poor in the assessment of climate vulnerability through stronger representation, identified problems will be too narrowly defined, proposed interventions will not be adapted to the real life contexts of urban inhabitants, and implementation will either be poorly organized or not undertaken in a manner that meets the needs of the most vulnerable groups.

3. Study area

Kota is the third largest city in Rajasthan and a declared counter-magnet city to Delhi. Its climate is characterised by low precipitation and high temperatures (mean annual precipitation 660 mm; average daily (24 h) temperature per month ranging from 17 to 36 °C) with extremes evening exceeding 48 °C. The average temperature in Rajasthan is projected to rise by approximately 2 °C by the 2041–2060 period, with the highest increases in the southeast where Kota is situated (GoR, 2011). Kota heavily depends on the Chambal River for its water supply. The city hosts a variety of industries, which provide jobs and economic growth, yet at the cost of significant levels of industrial and sewage water effluents (GoR, 2011; DoE, 2010). Some of Kota city's water reservoirs and *nallahs* (small streams) are becoming increasingly polluted, in particular in certain slums and newly settled areas that lack proper sewage and sanitation facilities and where many small-scale industries are located (Gangawala, 2011). The majority of settlements lie adjacent to various water sources, reservoirs, *nallahs* and the Chambal River. In the early 2000s, around 70% of people in Kota's slums lacked access to safe sanitation and were left without any other option than open defecation (ADB, 2007). Conditions have improved since then due to many government programs including "*Valmiki Ambedkar Awas Yojana*" (National Slum Development Programme), "*Swachh Bharat Abhiyan*" (Clean India Mission), "*Pradhan Manti Awas Yojana*" (Housing for All by 2022), and "*Rajiv Awas Yojana*" (Slum free India) (India Habitat III Report, 2016).

4. Methods

This paper focuses on results from a larger project that assessed climate vulnerability in two medium-sized urban centres in the Global South that face the challenges of rapid urbanization, expanding informal settlements and severe water problems. The outcomes from the vulnerability assessment process in Cochabamba, Boliva can be found in Wilk et al. (2017). The vulnerability assessments were based on a number of participatory exercises structured according to IPCC's 2007 definition of vulnerability – exposure, sensitivity and adaptive capacity (Parry et al., 2007). These exercises covered mapping and exploring challenges and opportunities related to climate change, handling climate impacts and identifying climatic and socio-economic stressors, locating sensitive sectors and groups and identifying and ranking the adaptive capacity of key actors. They were developed, performed and evaluated through interaction with local and regional stakeholders in the Baltic Sea Region (www.balticclimate.org; Jonsson et al., 2012) and South Africa (Andersson et al., 2013). In this study, a multi-stakeholder group in each city specifically formed for this purpose performed the exercises that they found relevant. Examples of the outcomes of the Kota and Cochabamba assessments were included in a published guide for integrated assessment and management of vulnerability to climate change (Wilk et al., 2013).

The vulnerability assessment process in Kota included representatives from various governmental and non-governmental organizations and educational and research institutes: District Collector's Office, *Nagar Nigam* (Kota municipality), *Zila Parishad* (District Council), Urban Improvement Trust (UIT), Housing Board, District Town Planning Office, Public Health Engineering Department (PHED), Department of Forestry, Department of Groundwater, *Rajiv Awas Yojna* (Slum-free India), The University of Kota and Government College, Kota. Twenty-five semi-structured interviews were held with representatives from local government departments responsible for health, housing and water supply, informal water committees and community representatives from low- and high-income areas to gain more detail on urban water challenges. The exercises were performed during three workshops between 2012 and 2014. Between workshops, literature searches were conducted to find additional information on the magnitude and eventual side effects of the identified climate-related challenges. Data was also gathered from a detailed slum survey in Kota carried out from 2010 to 2014 by the Ministry of Housing & Urban Poverty Alleviation in the *Rajiv Awas Yojna* program. Transect walks, observation, informal meetings and conversations with Kota inhabitants and participation in other organizational meetings also informed the multi-stakeholder process. Detailed descriptions and outcomes from the first two stakeholder meetings in Kota can be found in Jonsson et al. (2015). The key outcomes of the entire vulnerability assessment process are presented and analysed in this paper. The proposed interventions were categorized according to three key elements for strengthening urban resilience: systems (infrastructure and ecosystems), agent capabilities and institutions. The identified barriers and facilitating factors were placed in Moser and Ekstrom's (2010) spatial (proximate-remote) and temporal (contemporary-legacy) matrix according to where they originated. Proximate refers to the close physical space, in this case the municipality, and remote to the more distant space, e.g. state or nation. Contemporary refers to the present and legacy to the more distant past.

Table 1
Climate-related challenges in Kota.

Major challenges	Specific challenges
Groundwater depletion	Overuse, poor distribution systems, insufficient recharge
Uncontrolled urbanization	Increasing slums, open defecation, air pollution from traffic
Deforestation	Urban encroachment on forests and agricultural land
Water quality	Insufficient sewage treatment, polluted drinking water, decreased rainfall
Management issues	Policies are poorly implemented, lack of an integrated approach and community involvement
Other	Vector borne diseases, solid waste management, heat islands

5. Results

5.1. Urban challenges

The main challenges identified by Kota stakeholders (Table 1) are typical of climate-related issues that many urban areas in low- and middle-income countries face: groundwater depletion, insufficient sewage treatment and water- and waste management. Heat waves and in particular the urban heat island effect, where urban areas consistently experience higher nocturnal temperatures than the surrounding rural areas, are especially severe in Kota. The challenge considered most significant as well as highly likely to increase in the future in light of climate change was groundwater depletion, followed by deforestation and unplanned urbanization. As the vulnerability assessment specifically focused on climate change, the group chose to focus on groundwater depletion and heat wave effects more closely in the subsequent assessment process.

5.2. Who is vulnerable?

Vulnerability levels are highly correlated with factors including poverty, age and neighbourhood residence (Moser and Satterthwaite, 2010; Panda, 2011). In Kota, the process participants perceived most factors that contribute to vulnerability (Table 2) to be over-represented in slum areas, with the exception of age. The results of this exercise highlighted how some vulnerability factors such as socio-economic differences are closely linked with varying degrees of capacity to handle climate-related impacts. This led to an invitation to the ward members from slum areas and representatives of the *Rajiv Awas Yojna* program to participate in the following workshops of the assessment process. At the subsequent workshop, the challenges considered to be of greatest significance to address in the vulnerability assessment were adjusted to put more focus on slum populations. Groundwater depletion was no longer prioritized, partially because many of the suggested measures such as increased groundwater recharge were already included in current state and city policies and initiatives, and instead flood prevention was brought to the foreground together with urban greening to address heat wave effects.

5.3. Interventions to address challenges

Stakeholders spoke about the negative effects caused by heat waves and urban heat islands, and how these are linked to deforestation and loss of agricultural land from unplanned urban expansion. Excessive heat poses many health challenges in South-Asian cities (Hajat et al., 2010) and the present mortality rate from heart diseases in India is expected to increase with the intensity and frequency of extreme temperatures (GoR, 2011). Participants pointed out several current measures to lessen and cope with excessively high temperatures as well as additional measures that would be needed in the future as temperatures rise (Table 3). These proposed interventions included both mitigation and adaptation measures. While many urban greening measures such as the establishment of urban green zones, shelterbelts and tree plantations are currently being developed in and around Kota, there was recognition that these efforts must be intensified. More robust shelters and homes for displaced and migrant people are being

Table 2
Vulnerable groups categorized according to key factors.

Factors	Groups
Age	Children (under 5 years) – lower immunity
	Elderly
Health	Physically handicapped - reduced mobility
	Physically weak – due to disease or malnutrition
Socio-economy	People below poverty line (deprived)
	Unemployed
	Illiterate and poor women -often responsible for earning and caring for family
	Bad habits (drinking, gambling, drugs)
Dwelling	Landless
	Slum inhabitants
	Migrants – in temporary unstable and unhygienic dwellings

Table 3
Interventions related to heat waves organized by resilience elements.

Infrastructure systems	Ecosystems	Agent capabilities	Institutions
Establish shelters/homes for displaced or migrant people	Develop/expand urban green zones Develop/expand shelter belts/tree plantations	–	–

established as a result of current government programs but it was pointed out that these measures would need to be greatly intensified to meet the demands of the expanding population.

To combat flooding, participants pointed out a number of suggested changes to infrastructure systems, e.g. construction of diversion channels and walls, establishment of warning systems and maintenance work e.g. the cleaning of *nallahs* (Table 4). The intervention classified under agent capabilities (in Table 4) was awareness raising activities to limit building in flood-prone areas. The suggested institutional intervention called for improved policies for dam opening procedures (Table 4). As in the case of heat waves, participants pointed out the need to construct adequate shelters and homes for migrant people and slum occupants to better withstand flood conditions.

5.4. Barriers to implementation and opportunities to overcome them

For flood prevention, the majority of barriers, categorized according to where in space and time that they have originated, are in the contemporary and proximate quadrant (Fig. 2a). This indicates that the barriers originated in the municipality (proximate) and in a recent time period (contemporary). They include political confusion, unwillingness to charge for water, unclear divisions of responsibility between departments and insufficient funds and delays in accessing them. A few barriers lie in the proximate-legacy quadrant indicating that they originated in the more distant past. The physical location of the city, on hard rock, was a past decision that dictates to what extent climate adaptation measures are feasible such as groundwater recharge and the fact that Kota has been a large city for some time limits land access for new purposes e.g. urban greening or relocation of slum populations. For urban greening, the majority of barriers also lie in the contemporary-proximate quadrant. Urban greening was not prioritized during the main construction phase of the central city, which leaves a legacy of extensive paved surfaces. As the benefits of urban greening are now acknowledged, the current lack of implementation and common understanding of green belts can be considered contemporary barriers. Unplanned urban growth, common in most large cities of the Global South, can be seen as originating in the more distant past (legacy), as many unplanned areas of the city were established long ago but news areas continue to be established and are likely to increase in number and land are in the future. As for the barriers, the majority of facilitating factors for both measures, flood prevention and urban greening (Figs. 1b and 2b) lie in the contemporary-proximate quadrant except for the availability of state and national funds to establish flooding prevention measures which lies in the contemporary-remote quadrant.

5.5. Stakeholder action plans

Kota stakeholders outlined a number of specific actions that could be undertaken based on the collective learning and outcomes of the vulnerability assessment (Tables 5 and 6). The actions focused on increasing urban greening and the cleaning and eventual coverage of *nallahs* coupled with more efficient solid waste management. The required frequency of the actions and the responsible actors were also recorded. Kota municipality is identified as a key actor in almost all of the actions, with the exception of distributing plants to households (Forestry Department) while some activities were considered to benefit from greater collaborative responsibility e.g. planting, awareness and education campaigns and monitoring *nallah* blockages. No specific actors were assigned to some of the actions under urban greening.

6. Discussion

Proposed interventions related to mitigating the effects of heat waves with urban greening were very concrete. They involved creating and enhancing ecosystems, shelterbelts and tree plantations (Table 3). No interventions related to agent capabilities or

Table 4
Interventions related to flooding organized according to resilience elements from Tyler and Moench (2012).

Infrastructure systems	Ecosystems	Agent capabilities	Institutions
Establish early warning systems for floods	–	Awareness raising about not building flood-prone areas	Make policies that direct responsible dam opening procedures
Build water-returning walls			
Clean *nallahs*			
Establish shelters/homes for displaced or migrant people			
Build a second diversion channel			

a

		Temporal	
		Contemporary	Legacy
Spatial/Jurisdictional	Proximate	• Lack of implementation • Unplanned urban growth • Slum dwellers' reluctance to re-locate • Unclear definition of "green belts"	• Extensive paved surfaces
	Remote		

b

		Temporal	
		Contemporary	Legacy
Spatial/Jurisdictional	Proximate	• The Forest Department regularly distributes trees for planting • Kota Disaster Management Plan and Kota Master Plan to 2023 (suggesting 5% green areas) • Existing laws and well-bdefined implementing institutions	• 100-ft green belt along highways • Large green military areas will not be encroached by urban expansion
	Remote		

Fig. 1. a Barriers to implementing urban greening. The row and column titles relate to the temporal and spatial/jurisdictional origins of the barriers relative to the municipality (i.e. where urban greening should be implemented). b Facilitating factors for implementing urban greening. The row and column titles relate to the temporal and spatial/jurisdictional origins of the factors relative to the municipality (i.e. where urban greening should be implemented).

Table 5
Action plan for urban greening.

Actions	Timeframe	Responsible organization
Identify the soil cover area		
Identify and ensure water source (tube well supply or pond)		
Select heat-tolerant plant species		
Distribute plants to households		Forest Department
Contract labour and involve local communities, schools and industries in planting		UIT, Nagar Nigam, Forest and Horticulture Departments
Plant in selected localities	Feb, June-Sept or anytime there is water	UIT, Nagar Nigam, Forest and Horticulture Departments
Enforce that households cultivate and protect rooftop plants		UIT

Table 6
Action plan for *nallah* maintenance and solid waste management.

Actions	Timeframe	Responsible organization/officers/persons
Undertake awareness and education campaigns	Monthly	UIT, Nagar Nigam, Ward members, Doctors, Senior citizens
Clean *nallahs*	Weekly	Nagar Nigam
Monitor blockages	Weekly	Nagar Nigam (Sub-inspector), Ward members, citizens
Enforce penalties for dumping and blockage of *nallahs*	At time of infringement	Nagar Nigam (Sub-inspector), UIT, Ward members
Cover *nallahs*, especially in narrow streets	One time	Nagar Nigam (Sub-inspector), UIT
Solid waste management - Place dustbins at appropriate places - Enforce regular pick-up - Make an environmentally friendly solid waste management plan		Nagar Nigam

institutions were recorded. This could be due to the fact that existing laws and plans already support these measures e.g. the Kota Disaster Management and Master Plans and that the institutions responsible for implementation e.g. the Forest Department and their areas of responsibility are well defined (Fig. 1b). The identified barriers and facilitating factors for most of the interventions lie in the contemporary-proximate quadrant, which indicates greater ease in addressing and overcoming them as they are not historically entrenched or involve distant actors (Fig. 1a). That urban greening is well established and perhaps involves fewer negative trade-offs could be one reason that it was focussed upon in a brief assessment. Yet where to green, especially in areas with extensively paved surfaces and the unclear definition of green belts, and which plants to choose, where some might provide additional benefits to marginalized groups, would however have to be discussed, negotiated, and decided upon. Even proposed interventions relating to construction and maintenance of infrastructure contain institutional issues that would need to be identified and accommodated in action plans to facilitate their implementation.

Although the multi-stakeholder group claimed that the risk of flooding had been averted due to the construction of a diversion channel in 2007, the exercises on vulnerable groups shifted their focus to the growing number of residents in makeshift dwellings on riverbanks and low-lying areas. It was recognized that slum inhabitants receive fewer services regarding drainage than middle class city dwellers and they are almost totally isolated from the urban wastewater network, so flooding greatly increases their risk for contracting water borne diseases and also threatens their assets and even lives. When proposing interventions to address flooding, as for urban greening, infrastructure development dominated, such as construction of a second diversion channel and protective walls (Table 4). In Gorakhpur, India where a targeted intervention aimed to increase climate change resilience in one slum community, wealthier households built boundary walls around their homes for flood protection, which increased the risk of water entering poorer households who could not afford such infrastructure (Bahadur and Tanner, 2014). The example clearly illustrates the complexity of implementing even seemingly simple infrastructural solutions. Without a deeper discussion of trade-offs that recognize the perspectives and needs of different marginalized groups, it is not certain that urban resilience will be fortified among the people that are in greatest need. Such discussions were not taken during the simple vulnerability assessment in Kota, yet such issues and multiple and even conflicting perspectives would need to be addressed before any implementation of the proposed actions stemming from the assessment process.

Other suggested infrastructural interventions for flood protection included the construction of temporary shelters in emergency situations and robust permanent dwellings in less-flood prone parts of the city. Discussions did address the fact that people living on riverbanks in central locations do not always want to re-settle on the peripheries of the city despite the lower risks for climate-related disasters (Fig. 2a). Visits to such a relocated slum revealed that loss of livelihood opportunities, lack of public transport and childcare made the new location much less attractive, particularly for women. High land prices, little available land and a steadily growing population problematize this issue even further. While such points were raised in assessment discussions, they did not lead to any concrete actions that reflect these multiple perspectives. Strong support from local inhabitants was recorded as a facilitating factor in implementing flood prevention measures (Fig. 2b) but without detail on which aspects and proposed interventions that inhabitants support, which inhabitants are the supporters and if marginalized groups are included among them. The wording in the documented outcomes does not seem to indicate actions that encourage social learning or procedural representation and equity as Yuen et al. (2013) and Chu et al. (2016) recommend for fostering strong urban resilience.

The inclusion of stakeholder knowledge has been found to be of key significance in fostering robust urban resilience measures (Kernaghan and da Silva, 2014). Stakeholders did mention accumulated knowledge including that from local inhabitants as a facilitating factor for the implementation of flood prevention measures (Fig. 2b) but also the fact that local knowledge is rarely used for combatting flooding and its impacts is a barrier to implementation of effective adaptation measures (Fig. 2a). Examples of proposed interventions involving local populations however did not indicate accessing and including their knowledge but rather focussed on building awareness about flood risks (Table 4) and educating people not to block *nallahs* and to monitor any found blockages (Table 6). In the flood prevention action plan (Table 6), urban organizations and community members i.e. ward members, doctors and specifically senior citizens were mentioned as co-responsible for awareness raising activities, yet without clarity of what their specific roles would be and how eventual social learning and collaboration between the actors would take place.

The inclusion of or partnerships between city champions, engaged government leaders and representatives of the academic, private sector and civil society have been found to be important factors influencing the success of vulnerability assessments and giving stability to the adaptation agenda (Kernaghan and da Silva, 2014; Chu et al., 2016). In the Kota action plans (Tables 5 and 6) the group did not define any “leader” institutions in the case where several were mentioned or note any names of specific people, departments or units, especially those of city champions and leaders especially engaged in the issues. This would most likely lead to ambiguity in responsibility when implementing any future actions. Only government institutions and agencies responsible for undertaking measures were named but no other key networks or organizations especially from the private sector or civil society. Ward members were mentioned in the plans, but not specifically those of slum areas. The most notable omission in the action plans was that of representatives from the *Rajiv Awas Yogna* program who even participated in the assessment process. This could have been because the program was to terminate shortly after the last workshop (in 2014) but especially in light of this, at least one representative of (and preferably more) an organization or program could have been named in the plans to ensure continued representation of the interests of the poor during the implementation phase.

The Kota vulnerability assessment, initiated and conducted primarily as a research exercise, was limited in scope and time. However the diversity of issues and perspectives brought up even in this brief assessment points to the complexity and magnitude of urban climate resilience issues in the city. Because of the limited temporal nature and extent of the assessment, it is understandable that the outcomes were dominated by concrete infrastructural measures that could be more easily identified and implemented instead of those where contested trade-offs, equity issues, unclear responsibilities, etc. were more immediately obvious. An important step is

a

		Temporal	
		Contemporary	Legacy
Spatial/Jurisdictional	Proximate	• Political confusion and unwillingness to charge for water • Inadequate maintenance • Unclear division of responsibility between government departments • Little use of local knowledge • Insufficient funds and time lag • Lack of political will	• City lies on hard rock • Little land access for building homes and shelters
	Remote		

b

		Temporal	
		Contemporary	Legacy
Spatial/Jurisdictional	Proximate	• Accumulated knowledge of local people, technical experts, consultants and public leaders • Strong support from local inhabitants • Positive effect and example of first constructed diversion channel • Kota Disaster Management Plan and Kota Master Plan (until 2023)	
	Remote	• Available funds from Nation Capital Regional Investment Plan and the State (of Rajasthan)	

Fig. 2. a Barriers to implementing flood prevention measures. The row and column titles relate to the temporal and spatial/jurisdictional origins of the barriers relative to the municipality (i.e. where flood preventions measures should be implemented). b Facilitating factors for implementing flood prevention measures. The row and column titles relate to the temporal and spatial/jurisdictional origins of the factors relative to the municipality (i.e. where flood preventions measures should be implemented).

however also to move from assessments, however incomplete, towards implementation (Nordgren et al., 2016). Since the perspectives and needs of marginalized groups have not been clearly discussed or documented in more detail in the assessment outcomes, there is a high risk that they would be overlooked at the implementation phase, especially if new stakeholders become involved. The inclusion of the representatives of the *Rajiv Awas Yogna* program in the assessment did lead to consideration of the needs of the vulnerable residents, one of Chu et al. (2016) criteria of inclusive approaches, yet the process did lack procedural representation, whereby all urban public, private and civil society actors adequately participate in the adaptation process. As Bahadur and Tanner (2014) suggest for transformation to take place the perspectives of marginalized populations must be understood and the institutions, vested interests and powerful actors must be challenged. Despite a pivotal shift in the process to the issue of flooding, the inclusion of a stakeholder that represented marginal groups and some discussion about the perspectives of slum dwellers towards re-location and the importance of local knowledge, the Kota vulnerability assessment did not fulfill a number of key conditions or produce outcomes that would enable transformation to greater urban climate resilience and social equity.

7. Conclusion

Despite focus on flooding which disproportionately affects the poor in flood-prone locations and discussion of some issues where their perspectives differed from middle-class inhabitants and government officials, vulnerable groups, such as slum inhabitants or their interests, were not well represented in the vulnerability assessment process or the recorded outcomes. There were no stakeholders that specifically represented the needs of the vulnerable, either by indirect or direct representation, named as co-responsible for any actions related to urban greening or flood prevention. Local inhabitants were named as participants in concrete activities such as planting or monitoring *nallah* blockages or recipients of awareness and education campaigns that suggest behavioural changes. There were no actions that involved usage of local knowledge, although this was acknowledged as important to promoting robust adaptation activities around flood prevention or that promoted social learning, collaboration and improved organizational capacity of the key targeted actors.

While the intervention areas themselves and the measures outlined in the action plans do not seem to address any strongly

contested issues, when actual locations need to be decided upon in an implementation phase i.e. where systems-infrastructure and ecosystem elements will be placed and what consequences suggested locations would have for different societal groups and areas, very different perspectives might emerge. For this reason, it is very important to have a strong balance of representatives of vulnerable groups such as slum inhabitants, to ensure that their perspectives and needs are heard and even prioritized to favour greater equity among city residents. Without this strong representation in vulnerability assessments and implementation of suggested measures, urban resilience will continue to uphold current conditions and protect the middle-class rather than meet the needs of the most vulnerable groups and enable a shift in the current equity order.

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